CONSTRAINTS ON THE FORMATION AGE AND EVIDENCE FOR THERMAL DEMAGNETIZATION OF THE MOON'S REINER GAMMA MAGNETIC ANOMALY. M. R. Kelley[1], I. Garrick-Bethell[1,2], S. J. Goossens[3], [1]University of California, Santa Cruz, [2]Kyung Hee University, [3]NASA Goddard Space Flight Center.

Introduction: The most enigmatic lunar crustal magnetic anomalies are known as swirls. Swirls are ~10-200 km regions of high-albedo soil that form curved shapes, and each swirl has an accompanying magnetic anomaly [1]. The leading hypothesis for the soil's high albedo is that the local magnetic field creates a 'mini-magnetosphere', protecting the surface from solar wind ions that typically cause regolith darkening [2]. However, the origin of the source body that produces the magnetic anomaly is still unknown.

Gravity analysis: We have discovered that the 'tail' of Reiner Gamma, the Moon's archetypical swirl, cross cuts a buried crater (Fig. 1). This finding can be used to constrain the depth of the Reiner Gamma source body. Evans et al. [5] also reported this crater and argued that a negative relative Bouguer anomaly only results from craters that formed in existing volcanic deposits. Therefore, we conclude that the Reiner Gamma source body must have been emplaced between episodes of mare volcanism or approximately between 3.3-3.9 Ga using the local surface ages of [6].

Thermal analysis: We use the swirl albedo pattern's correlation with magnetization [3] to investigate the relationship between subsurface magnetization and geologic features at a resolution far greater than possible when using high-altitude spacecraft measurements of the magnetic field. We have used this insight to discover that the albedo pattern of Reiner Gamma tail is correlated with local volcanic domes, providing the first evidence of thermal demagnetization of a magnetic body on the Moon. The demagnetization is from the heat introduced by the eruption of the Marius Hills, one of the most densely erupted volcanic complexes on the Moon [4].

Scientific Implications: We have produced a first-order thermal model where the input parameters are the observed sizes of the heat-producing bodies and the inferred demagnetization distances seen in the swirl morphology, and the output of the model is magma fill fraction: what fraction of an intruding body is filled with magma at any given moment. Using this model, we have obtained magma fill fractions that are in the 25-50% range. Because these values for magma fill fraction are physically likely, this implies that thermal demagnetization is a plausible explanation for the observations at the northeastern termination of the Reiner Gamma swirl (Fig. 2): the brightest parts of the swirl do not overprint local maxima in topography.

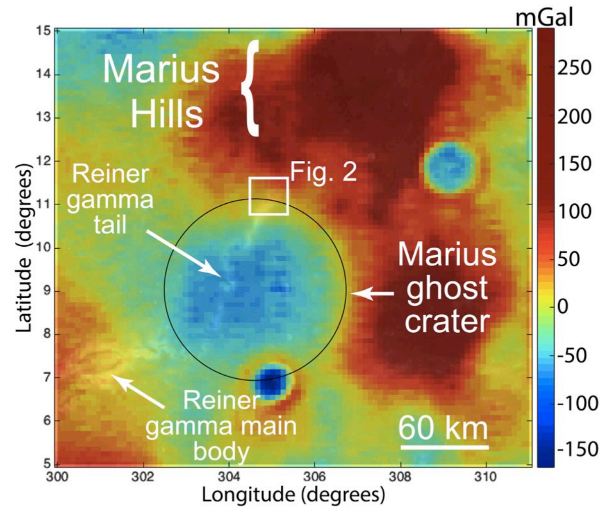

Fig. 1 – Bouguer gravity map in the area of Reiner Gamma swirl [7]. A map of reflectance is overlain; Reiner Gamma is in the southwest. The solid black circle indicates a buried crater.

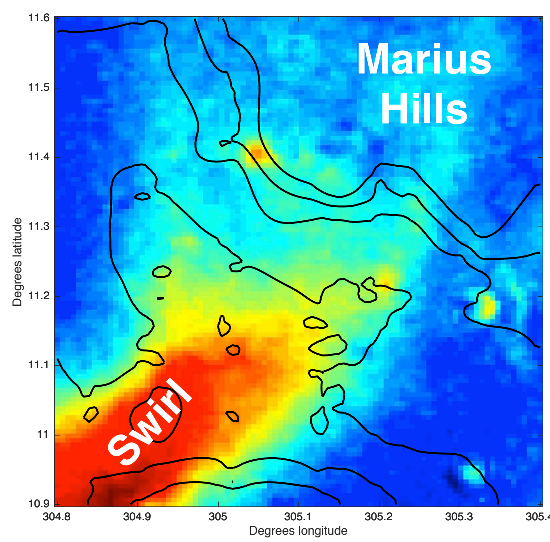

Fig. 2 – Red/blue colors indicate reflectance values, and the red areas are the bright portions of the swirl. Black contours show topography (250 m range).

References: [1] Blewett, D.T. et al. (2011) *JGR Planets* 116, E02002. [2] Hood, L.L. and Schubert, G. (1980) *Science* 208, 49-51. [3] Hemingway, D. and Garrick-Bethell, I. (2012) *JGR Planets* 117, E10012. [4] Kiefer, W.S. (2013) *JGR Planets* 118, 733-745. [5] Evans, A.J. et al. (2016) *GRL* 43, 2015GL067394. [6] Hiesinger, H. et al. (2003) *JGR Planets* 108, 5065. [7] Goossens, S. et al. (2014) *GRL* 41, 3367-3374.